PLANT SITE GROUNDWATER
ASARCO EAST HELENA PLANT

This Plant Site Groundwater Summary considers groundwater on and in the vicinity of the plant.

For purposes of this summary, the discussion is structured as follows:

- Groundwater RI/FS
  - * Investigation Methods
  - * RI/FS Investigation Results
  - * Remedial Alternatives:
    - * Alternative Considered in the FS
    - * Alternatives Recommended in the FS
    - * Alternatives Implemented
- Post-RI/FS Data
  - * Post-RI/FS Investigations and Methods
  - * Post-RI/FS Monitoring Results
  - * EPA Comments to Post-RI (1990-1994) Data Report

GROUNDWATER RI/FS

Investigation Methods

The RI/FS investigation was conducted from 1984 through 1987 investigation methods included:

- Collection and trace element analysis of stratigraphic samples from drilling of 63 soil core holes.
- Installation of 51 monitoring wells.
- Collection of groundwater samples from 41 monitoring wells and 33 privately owned wells from 1984 through 1988.
  Aquifer testing of 38 monitoring wells.

GROUNDWATER RI/FS

RI/FS Groundwater Investigation Results

Stratigraphy and Groundwater Flow

- Depth to groundwater within the study area ranges from approximately 6 feet to 60 feet below the ground surface.

- Groundwater flows through shallow (water table), intermediate and deep alluvial sand/gravel aquifers. Sand/gravel aquifers are typically separated by finer grained silt and/or clay layers. The deep aquifer is separated from the intermediate aquifer by fine grained volcanic ash/clay unit.

- Groundwater flow in the plant site area is to the north and to the northwest. Upper Lake, Lower Lake, and Prickly Pear Creek are local sources of recharge to shallow and intermediate aquifers. Other plant area sources including the Speiss Pond and Pit, the Acid Plant Water Reclaim Area (including the settling pond and sediment drying areas), and Thornock Lake also contributed recharge within the plant site area.

- Groundwater flow generally moves from the plant site to northern part of East Helena in about 1 year (average velocity about 5200 feet/year). shallow gw

RI/FS Groundwater Investigation Results

Groundwater Quality

- Water quality sampling and analysis showed the shallow aquifer (upper 10 feet of saturation) under the plant, and to some extent under East Helena, has elevated arsenic concentrations. This is illustrated by the arsenic concentration plume maps and by the data summaries for plant site and East Helena monitoring wells.

- Because the concentrations of other metals including cadmium and lead were generally low in the shallow (and intermediate and deep) aquifer, the primary metallic element of concern for groundwater during the RI/FS was arsenic. Contrary to arsenic concentrations, the concentrations of other metals in groundwater was not contourable and did not show any identifiable pattern relative to plant site or off site concentrations.

- Water quality analyses from the intermediate aquifer underlying the shallow aquifer do not show elevated arsenic (or other metals) concentrations. Some ~~elevated concentrations~~ of sulfate and TDS were observed. Elevated conc in plant area
  ↳ is this an indication of correction?
- Water quality analyses from the deep aquifer showed low concentrations of arsenic, metals, sulfate and TDS, and showed no effects from plant site sources.

- Arsenic and metal concentrations in most private wells were below MCL's (0.05 mg/l) for arsenic. One well averaged 0.059 mg/l. Private well quality is illustrated by data summaries for the private wells and on plume concentration maps. Private wells were completed in the shallow, intermediate aquifer or the deep aquifers. All private well supplies for drinking water in East Helena have been replaced (voluntarily by the owners) by the city water supply.

Are the private wells abandoned? Are they used for things other than Drinking H_2O?

RI/FS Groundwater Investigation Results

Groundwater Quality

- A northwest trending, relatively high concentration arsenic plume was delineated in the shallow groundwater system on the plant site. Primary sources of the plume were the speiss granulating pit and pond, the acid plant water treatment facility and drying areas, and losses from the process fluid circuits.

- The multi-source plume is superimposed on a broader, lower concentration arsenic plume associated with Lower Lake. This lower concentration arsenic plume also extends to the north and northwest, in the general direction of groundwater flow.

- Calculated groundwater flow and groundwater and stratigraphic geochemical analyses indicate geochemical and physical reactions with arsenic are attenuating the arsenic plumes. The plumes are attenuated both laterally and vertically.

- Attenuation mechanisms include coprecipitation, adsorption and ion exchange. Arsenic migration is particularly influence by oxidization state.

- Groundwater in some plant site monitoring wells also contained low levels of semi-volatile organic constituents. Analytical techniques and a review of historic documents indicated the source was most likely fuel oil, which was used for about a 10 year period during the late 1920s to fire the Sinter Plant. Fuel oil was replaced in the 1930s by natural gas. Fuel constituents in groundwater since have been weathered leaving no detectable volatile constituents and only a few detectable trace concentration semi-volatile constituents.

Source of high pH gw from pit process water. Pit also from granulating a caustic as product

They believe the oxidation state of arsenic is changed and contributing to its attenuation

As+3 is more mobile than As+5

Residual organics from fuel oil in 20's

REMEDIATION ALTERNATIVES

Alternatives Considered in the Feasibility Study

- **No Action Alternatives:**
  - * No Action
  - * No Action + Implementation of Process Pond Alternatives as Outlined in the Process Pond ROD

- **Limited Action Alternatives:**
  - * Aquifer monitoring, replace private wells with city water, and institutional restrictions on shallow and intermediate aquifer use.

Some wells are in use for lawn watering, private wells below MCLs at that time

– They think that a city ordinance prohibits private wells for drinking water – no ban on lawn watering
shallow aquifer 10-12 gpm enough for domestic uses

- **Source Containment Alternatives:**
  - Withdrawal wells for plume migration control
  - Injection wells for plume migration control
  - Interception and infiltration trenches
  - Slurry wall (alone or in combination with pumping or injection wells)

they have alot of data on how they could intercept the gw

- **Alternatives Involving Treatment:**
  - * Pump and treat water at an on-site treatment facility - discharge to POTW
  - * Pump and treat water at an on-site treatment facility - discharge to Prickly Pear Creek
  - * Pump and treat water at an on-site treatment facility - discharge to an infiltration gallery or groundwater injection wells
  - * Pump and treat water at an on-site treatment facility - discharge by land application
  - * In-situ treatment using permeable treatment beds
  - * In-situ treatment by fixation: pH control and chemical and or mechanical oxidation to groundwater.
  - * Biodegredation of organic constituents

REMEDIATION ALTERNATIVES

Alternatives Recommended in the FS

- Groundwater and Surface Water Monitoring + Implementation of Process Pond Remediation in accordance with the Process Pond ROD (1989).

Alternatives Implemented

where is this requirement codified? Nobody remembers

- In accordance with EPA direction, Post RI/FS Groundwater and Surface Water Monitoring was initiated in Spring 1990 and has been conducted on a bi-annual basis for 8 seasons.

- The primary purpose of Post-RI/FS monitoring is to monitoring effects on groundwater from implementation of Process Pond remedial action in accordance with the Process Pond ROD.

- There has been no ROD that directly addresses active groundwater remediation. The Process Pond ROD addresses process fluid sources of arsenic and metals to groundwater:

- Remedial action on Process Pond sources to groundwater included:
  - * Excavation of Thornock Lake - Completed 1991.
  - * Speiss Pond Remediation - Completed 1992.
  - * Excavation of Acid Plant Settling Pond - Completed 1993.
  - * Speiss Pit Remediation - Completed 1995.
  - * Lower Lake Dredging - Completed 1996.
  - * Excavation of Acid Plant Sediment Drying Areas - Deferred (1996) pending further EPA evaluation.

- Process Pond remedial actions will be discussed in more detail in the Process Pond presentation.

POST-RI/FS DATA

Investigation Methods

At EPA direction, groundwater monitoring has continued at the Plant Site and surrounding area on a biannual basis since 1990. To date, this has included:

- Seven biannual (spring and fall) sampling events at 39 area monitoring wells during the period Spring 1990 through Spring 1993. Analysis focused on key indicator parameters including arsenic, cadmium, copper, lead and zinc. Organic constituents a selected wells, based on RI data, were also monitored.

- Eight biannual sampling events at 55 area monitoring wells during the period Fall 1993 through Spring 1997. Fifty-two wells monitor shallow groundwater, 2 wells monitor intermediate groundwater, and 1 well monitors deep groundwater. Analytical parameters were generally the same as those monitored during the 1990-1993 period.

- Collection and trace element analysis of stratigraphic samples from drilling of an additional eight soil core holes to investigate options associated with Lower Lake.

- Installation of eight, 2 inch monitoring wells adjacent and down gradient of Lower Lake. To inv LL remediation as it was taking place also inc LL SW monitoring.

- During the period of Spring 1994 through Fall 1996, groundwater was monitored at an increased frequency at 16 wells located in the vicinity of Lower Lake. This monitoring was associated with the Lower Lake Remediation Project.

POST-RI/FS DATA

Post-RI/FS Monitoring Results

- The arsenic plume underlying the northern portion of East Helena (Gail Street) has been in a steady state condition for the monitoring period 1987 - 1997. This is illustrated by temporal plots for East Helena Monitoring Wells EH-53, EH-54 and EH-62.

- Some plant site monitoring wells showed a pattern of fluctuating arsenic concentrations in groundwater. These fluctuations are likely associated with plant process activities and remediation activities. The fluctuation pattern shows a general trend of decreasing arsenic concentrations since 1994-1995. This pattern is illustrated by temporal plots for:

  * DH-21 North of Dross Plant
  * DH-22 North of Acid Plant (Cottrel)
  * DH-27 West of Blast Furnace
  * DH-28 Northwest of Dross Plant

- Most Plant Site wells show recent trends of decreasing arsenic concentrations. This pattern is illustrated by temporal plots for:

  * APSD-3 Acid Plant Sediment Drying Area
  * DH-29 Acid Plant Sediment Drying Area
  * DH-19 Northwest of former Acid Plant Settling Pond
  * DH-23 Southeast corner of Change House
  * DH-13 East of New Ore Storage Building
  * DH-17 Northwest of Zinc Plant Bag House
  * DH-24 South of American Chemet
  * DH-06 North of Slag Pile by Highway 12

POST-RI/FS DATA

Post-RI/FS Monitoring Results

- Monitoring wells with notable trends of increasing arsenic concentrations during the Post-RI/FS period are:

  * Plant Site wells
    - APSD-02 East edge of Lower Lake Dewatering Pad
    - APSD-13 Just inside (north) of the flue, southwest of D&L Storage Building

  * Offsite
    - EH-60 Northeast of Highway 12 and 1st Street intersection.

- Post-RI/FS water quality from most private wells (5 wells monitored 1990 to 1994, 4 wells 1994 through 1997) showed little change from data collected during the RIFS. One well did show an increase in arsenic concentrations from 0.059 to 0.09 mg/l. These concentration were not observed in nearest shallow aquifer monitoring wells (EH-59 at 0.008 mg/l).

- Wells monitored for organic constituents generally showed little change from organic concentrations measured during the RI. No volatile organics were detected, and only trace amounts of semi-volatile organics were infrequently detected at some wells.

- An exception is well DH-27, which recently (since 1996) has shown evidence of diesel fuel. The source of fuel constituents in this well is recent and attributed to plant machinery used and maintained in the area. This apparent source has since been removed from the area. Monitoring is on-going to further assess the potential impacts associated with recent fuel constituents in groundwater near this well.

POST-RI/FS DATA

EPA Comments to Post-RI (1990-1994) Data Report

General Comments (March 1997):

- Review of existing groundwater data generally supports the conclusion that the arsenic plume underlying the north end of the plant and portions of City of East Helena appears to be in a steady state.

- The monitoring data are sufficient to address the current nature and extent of arsenic plume.

- The monitoring report needs to summarize data with respect to:

    * Trends
    * Remedial actions to mitigate groundwater impacts, and
    * Success/failure of remedial actions

- The report should discuss relevant plant activities to determine reasons for:

    * Dramatic arsenic fluctuations at wells DH-22 & DH-27.
    * Recent arsenic increases at DH-21, APSD-2, APSD-8 and EH-51.

- Discussion

DISSOLVED ARSENIC (mean mg/l)

Well	Location	Pre 94	Post 94	Post 95
Shallow Aquifer - Plant Site				
DH-21	N of Dross Plant	385	472	465
DH-22	N of Acid Plant (cottrel)	14	35	28
DH-27	W of Blast Furnace	46	46	33
DH-28	NW of Dross Plant	312	295	213
APSD-3	Acid Plant Sediment Drying Area	71	16	17
DH-19	NW of Former Swimming Pool	146	68	58
DH-23	SE Corner of Change House	5	2.9	2.7
DH-29	Acid Plant Sediment Drying Area	197	68	68
DH-13	E of New Ore Storage Building	158	45	35
DH-17	NW of Zinc Plant Bag House	109	78	80
DH-24	S of American Chemet	82	45	43
DH-6	N of Slag Pile by Highway 12	5.0	2.3	2.2
DH-10	N of Slag Pile by Highway 12	2.36	1.17	1.17
Shallow Aquifer - East Helena				
EH-52	E of Prickly Pear Creek	.9467	.4696	.4304
EH-58	E of Prickly Pear Creek	.0044	.0021	.0022
EH-59	E of Prickly Pear Creek	.0066	.0077	.0084
EH-50	W of Prickly Pear Creek	.0053	.0024	.0025
EH-51	W of Prickly Pear Creek	.4655	.4617	.4850
EH-53	W of Prickly Pear Creek	.0055	.0019	.0022
EH-54	W of Prickly Pear Creek	.0165	.0223	.0212

Off site

Well	Location	Pre 94	Post 94	Post 95	
EH-61 & EH-102	Intermediate Aquifer	.0083	.0021	.0022	
DH-18	Deep Aquifer	.0205	.0111	.0074	
Private Wells					
D Hulst	Private Well	.0209	.0171	.0168	−
Duel	Private Well	.0045	.0021	.0021	−
St. Clair	Private Well	.0599	.0864	.0980	+

Only deep aquifer well

Intermediate Aquifer has much higher As concentrations

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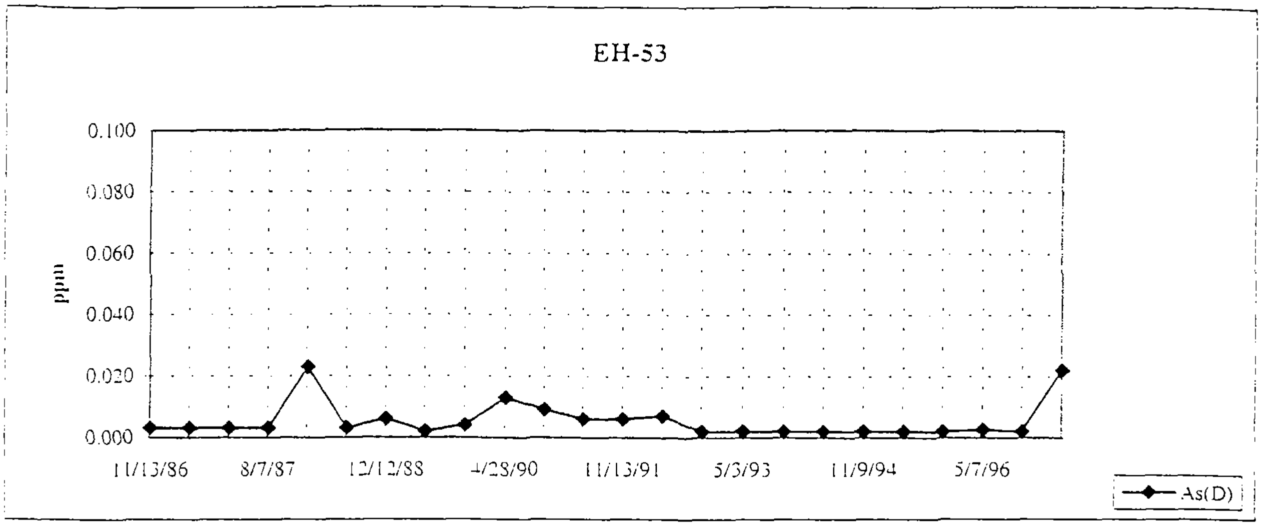
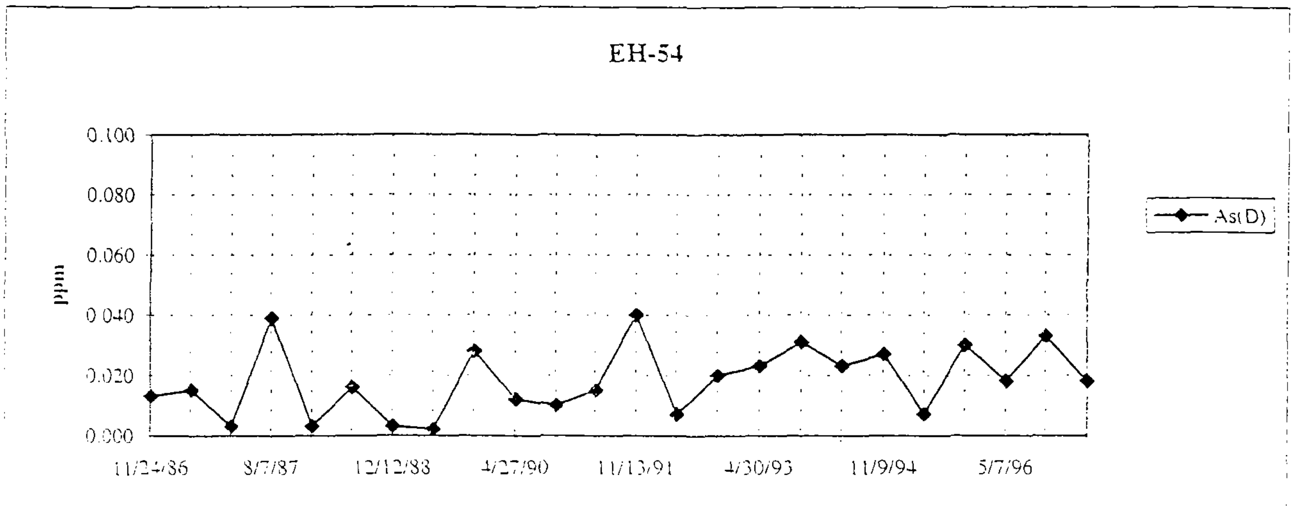
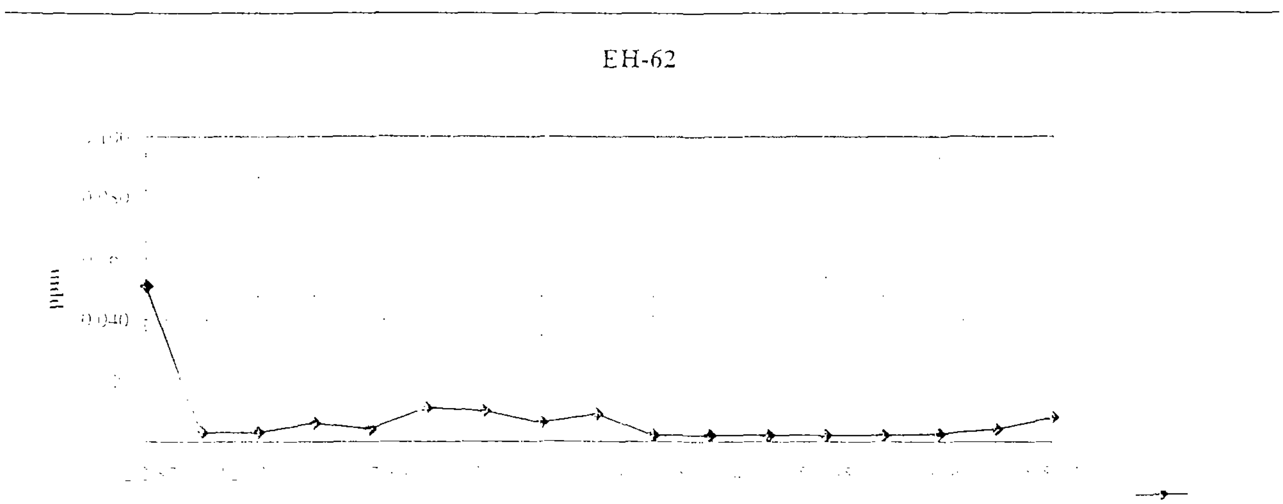
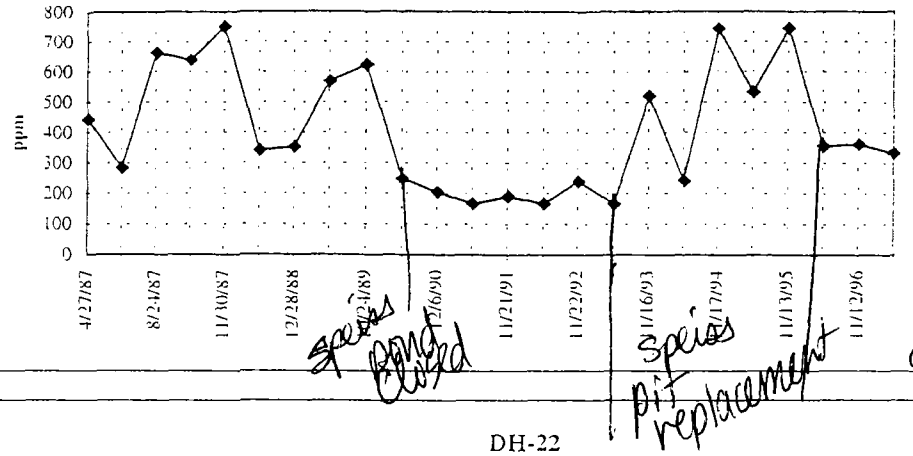






All shallow aquifer

DH-21

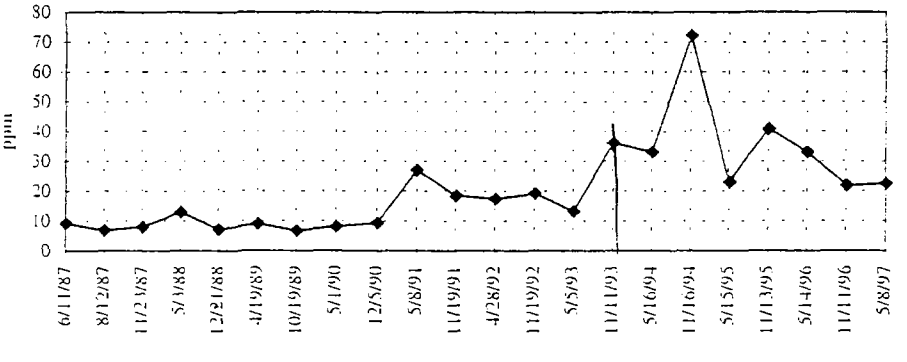


spikes pond closed

spikes pit replacement

cross plant

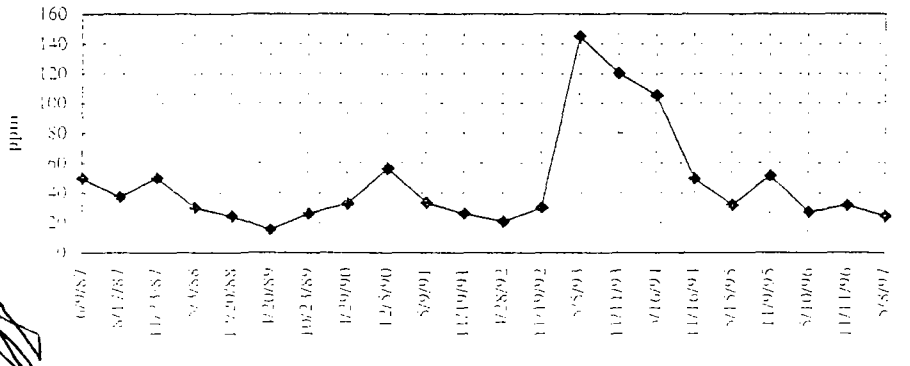
DH-22



acid plant

These are all dissolved As not +3 or +5 unspeciated data

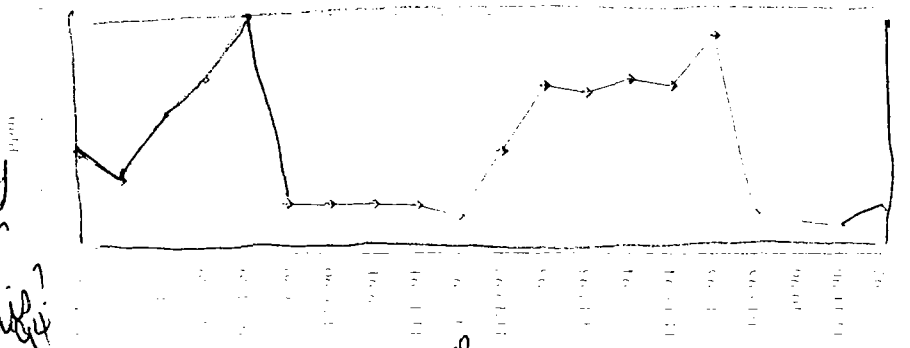
DH-27



BFurnace

On plant So probably mostly As+3

DH-28

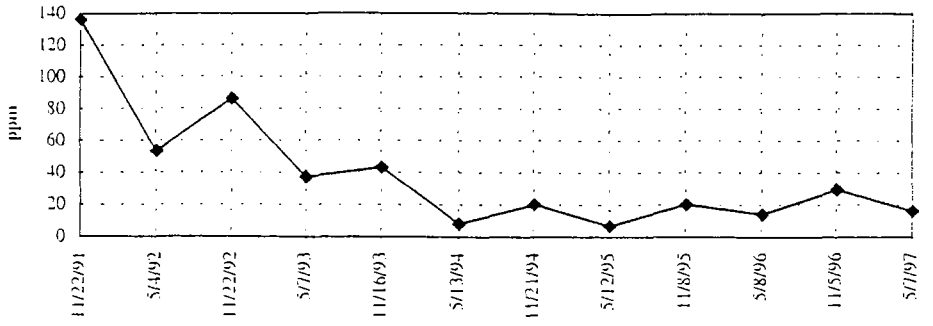


claim spikes from remediation but they are not certain. But they do not know what might have contributed if it was not remediation activities. Is there a report on this? Not since 94

May see future spikes due to plant circuit leaks

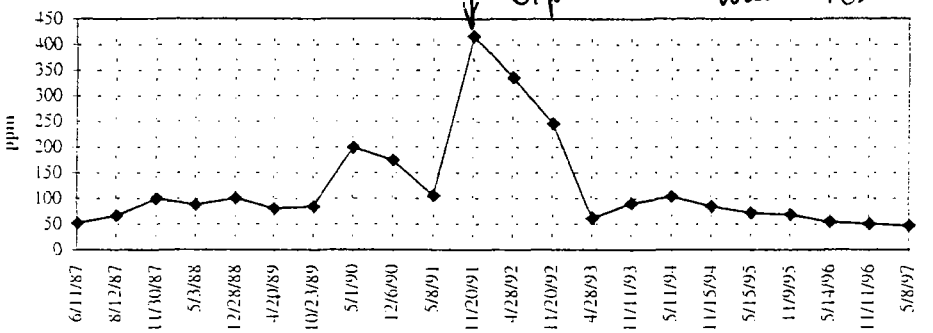
NW of cross plant

APSD-3



Acid plant sediment drying area

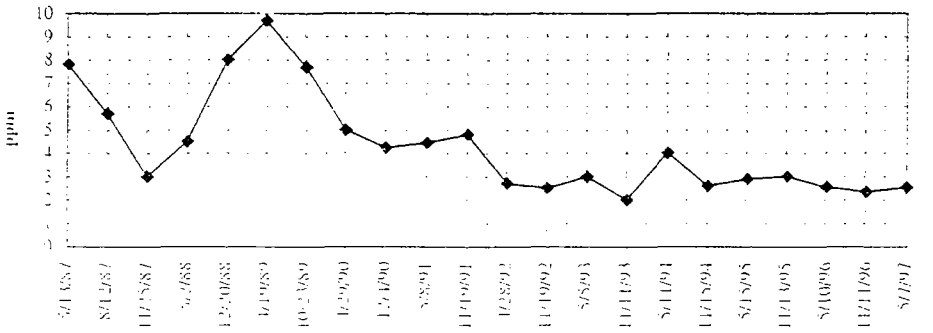
DH-19



expansion of sediment drying area resulted in direct measureable effect on gw

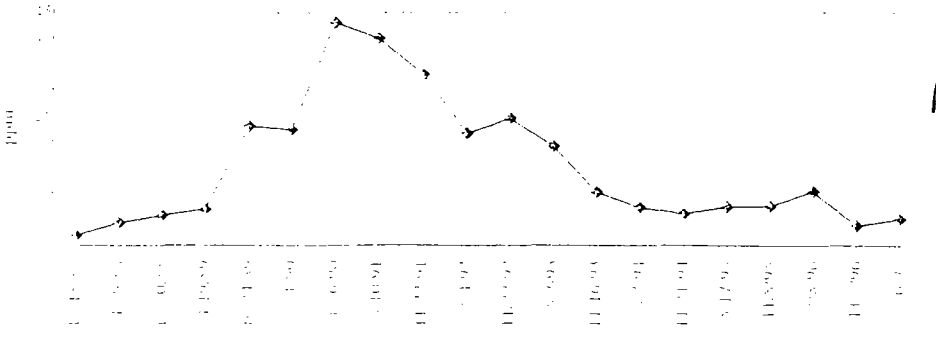
NW of former acid plant settling pond

DH-23

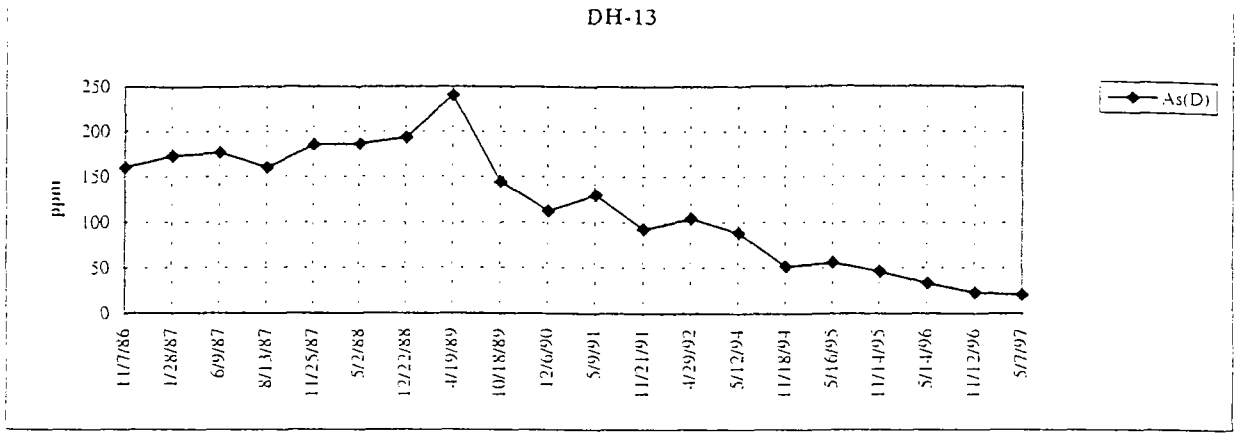


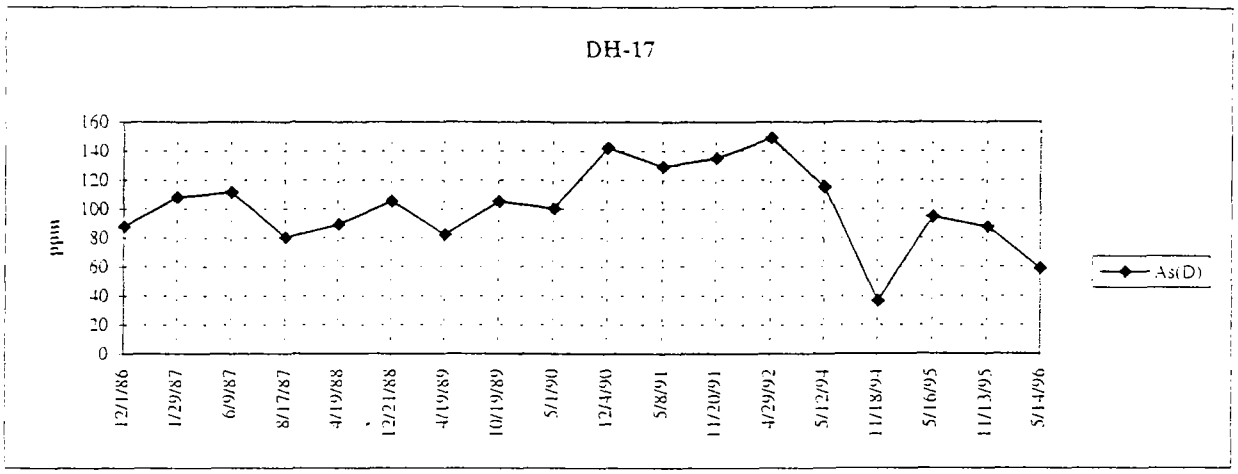
SE corner of change house

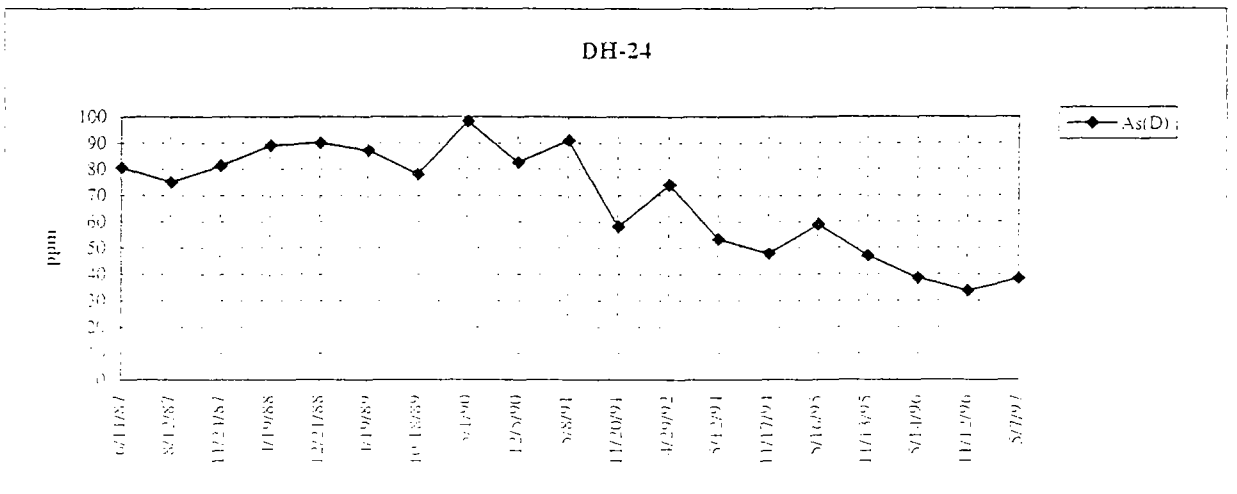
DH-29

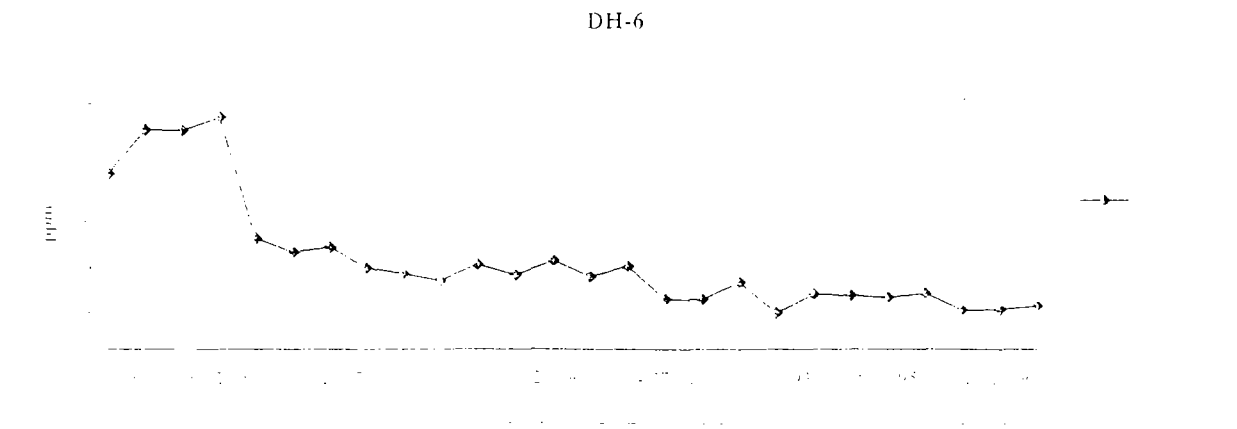


Acid plant Sediment drying area





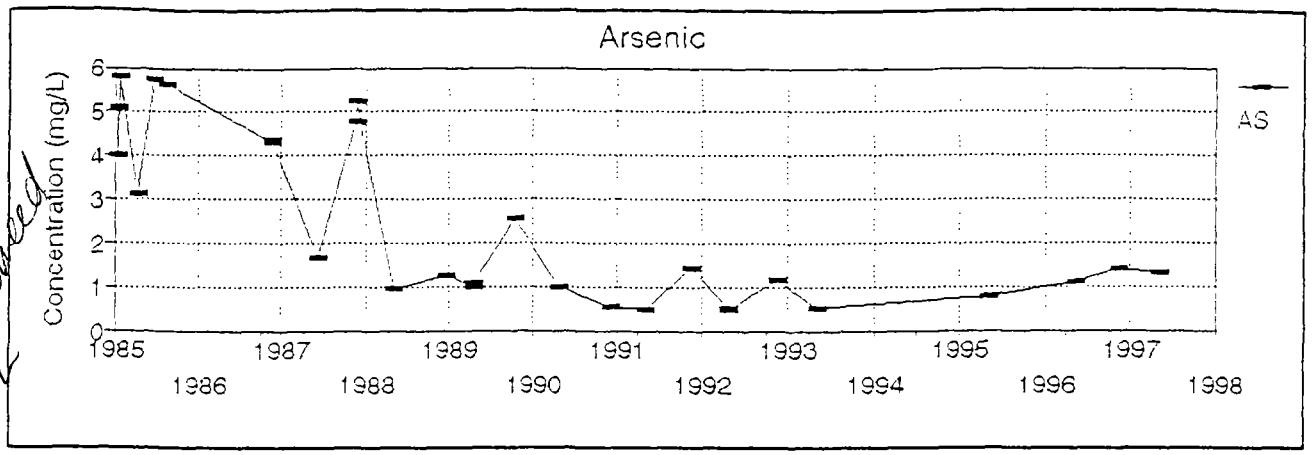




Down gradient wells

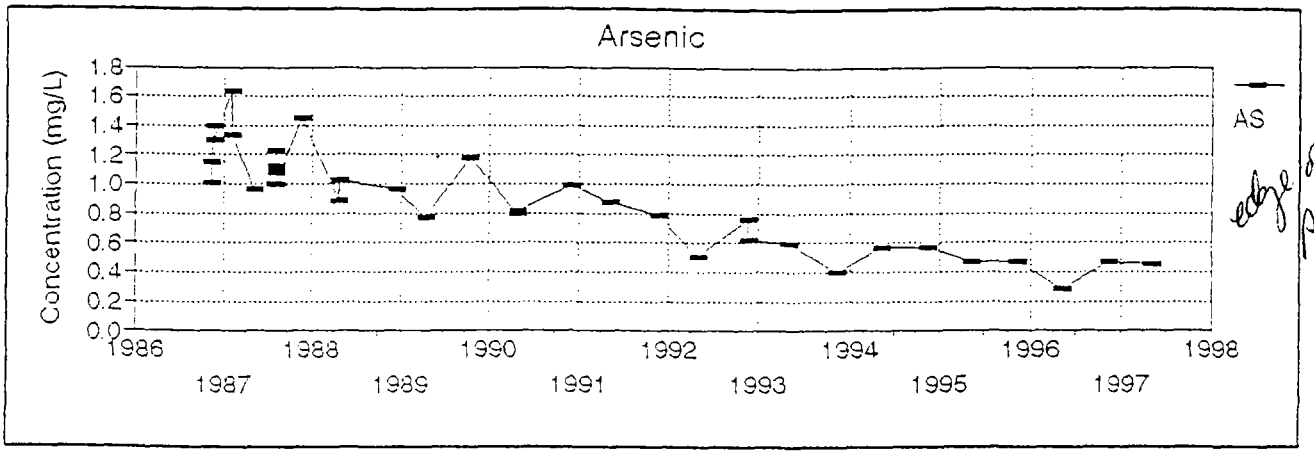
Attenuation + buffering of effects should not show upon these wells

DH-10

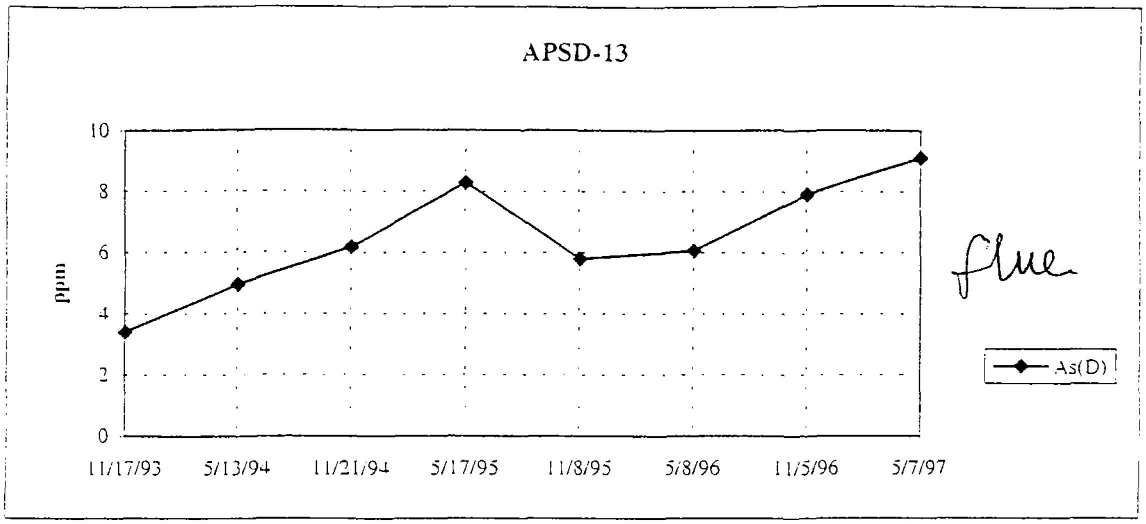


influenced by LL

EH-52

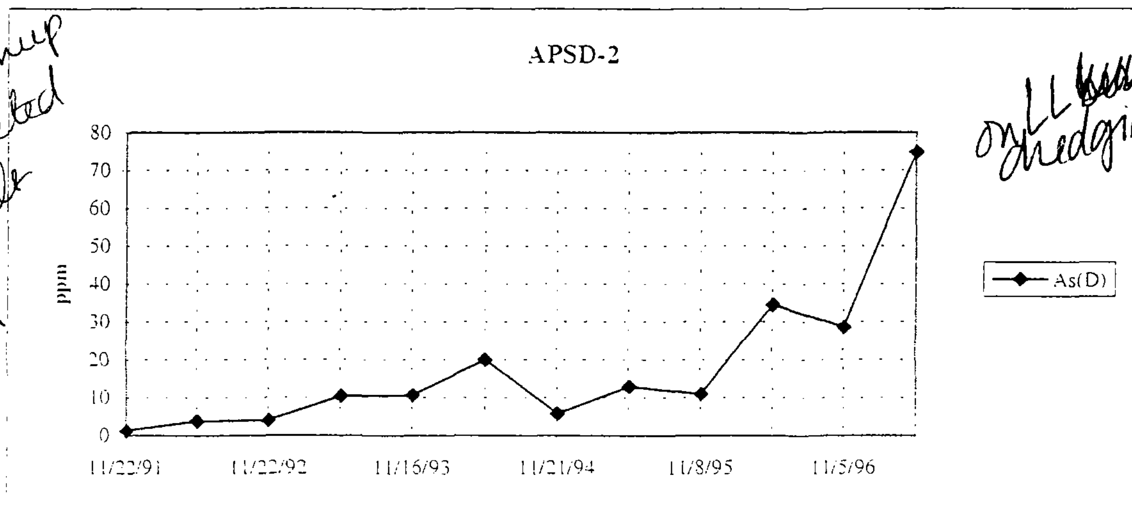


edge of the plume.



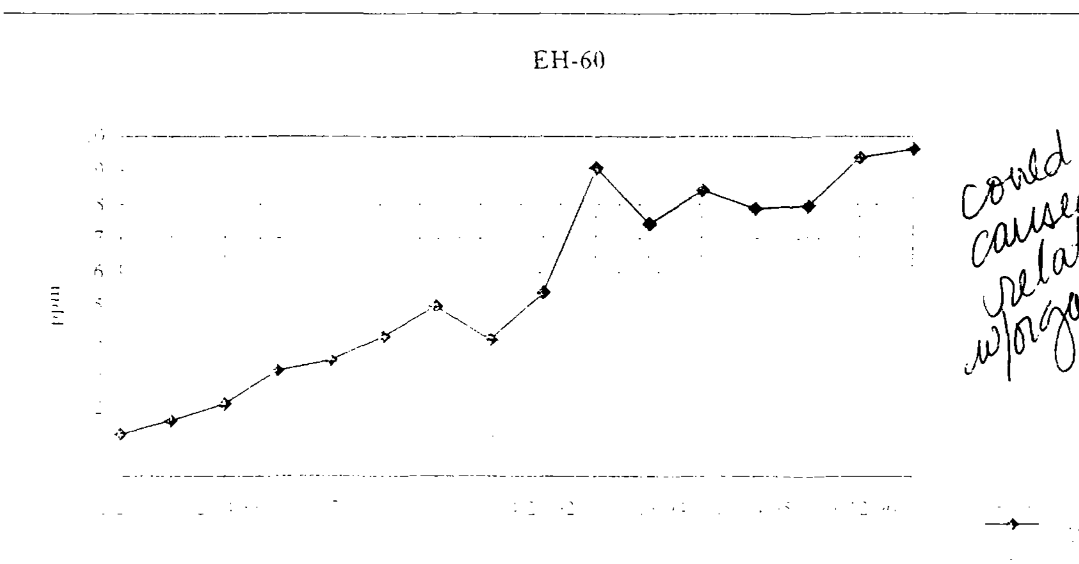
flue

in process pond cleanup area



on LL ~~basin~~ dredging area

Think LL cleanup has impacted these wells
APSD-7 on berm also erratic



could be caused by relationship w/organics